Landsat 7 Image Assessment and Quality Assurance

Purpose

- The Image Assessment System (IAS) was conceived by NASA to monitor and trend science data over life of Landsat 7

- By systematically sampling and analyzing the data delivered by the instrument we can understand changes happening on the instrument and derive the best calibrations for the data

- By using same processing algorithms as Level 1 Product Generation System (LPGS) we know and understand the output product delivered to our customers

Method

- IAS orders subset of data received (~ 4% of daily downloads) to analyze, process and trend
    - Geometric calibration scenes
    - Radiometric calibration scenes
    - Random data sample(s)
    - Various others (customer complaints, PR scenes, etc.)
- Averages 10 scenes per day
- Detailed performance data saved for each detector in each band along with various telemetry points
    - Large tending data base: approaching 100 GB
- Calibrations and predictions derived from this large data base

Method (cont.)

- To date IAS has processed and amassed detailed trending of over 5,000 Landsat 7 scenes

- IAS also has received additional trending data from 20,000 Landsat 7 scenes processed through LPGS

- Calibration Parameter Files:
  - 13 CPFs currently in effect
  - A total of 75 CPFs have been created since launch including updates

Method: IAS Coverage

- Over 5,000 scenes processed and analyzed by IAS

- Additional data from over 20,000 customer scenes

- Trending data base approaching 100 GB
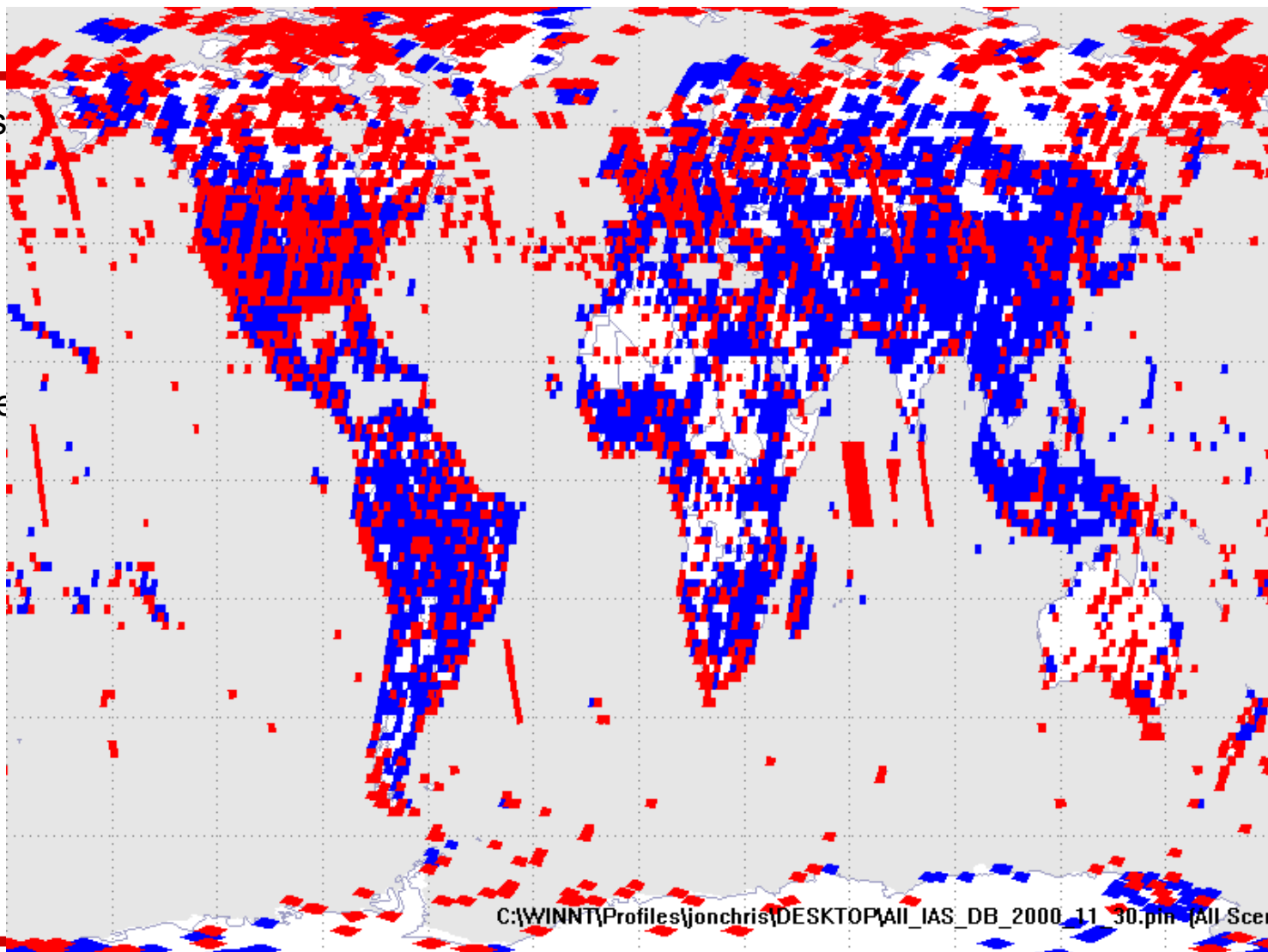
C:\WINNT\Profiles\jonchris\DESKTOP\All_IAS_DB_2000_11_30.pln [All Scen

Method (cont.)

- IAS Team at EDC works closely with Landsat 7 Project Science Office at GSFC

- IAS Team collaborates with members of Landsat 7 Science Team for further calibration, ground truthing, etc.

- IAS/EDC also makes use of resources at SBRS, builders of ETM+ instrument aboard Landsat 7

- Unexpected performance can also be detected

- IAS has worked closely with Mission Operations Center (MOC) at GSFC and Flight Ops Team to isolate operational problems, determine causes, then find and implement corrective actions in flight operations

GXA Disturbances

- GXA = Gimbaled X-band antenna(e)
- Three GXAs on spacecraft that can track ground stations as Landsat 7 flies overhead
- Scanning mirror affected by GXA vibration
- Most noticeable during fast movement
  - Big vibration before and after station tracking
  - During station tracking vibration is small, tolerable

Gimbaled X-Band Antennae (GXA 1,2,3)
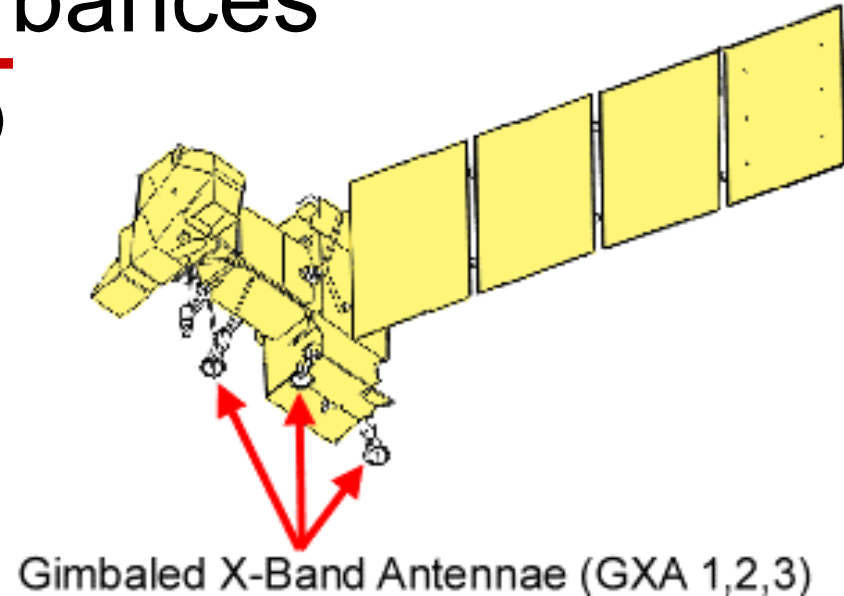
GXA Disturbance (cont.)

- Example of effect on scan line length (browse image, all scans left-aligned)
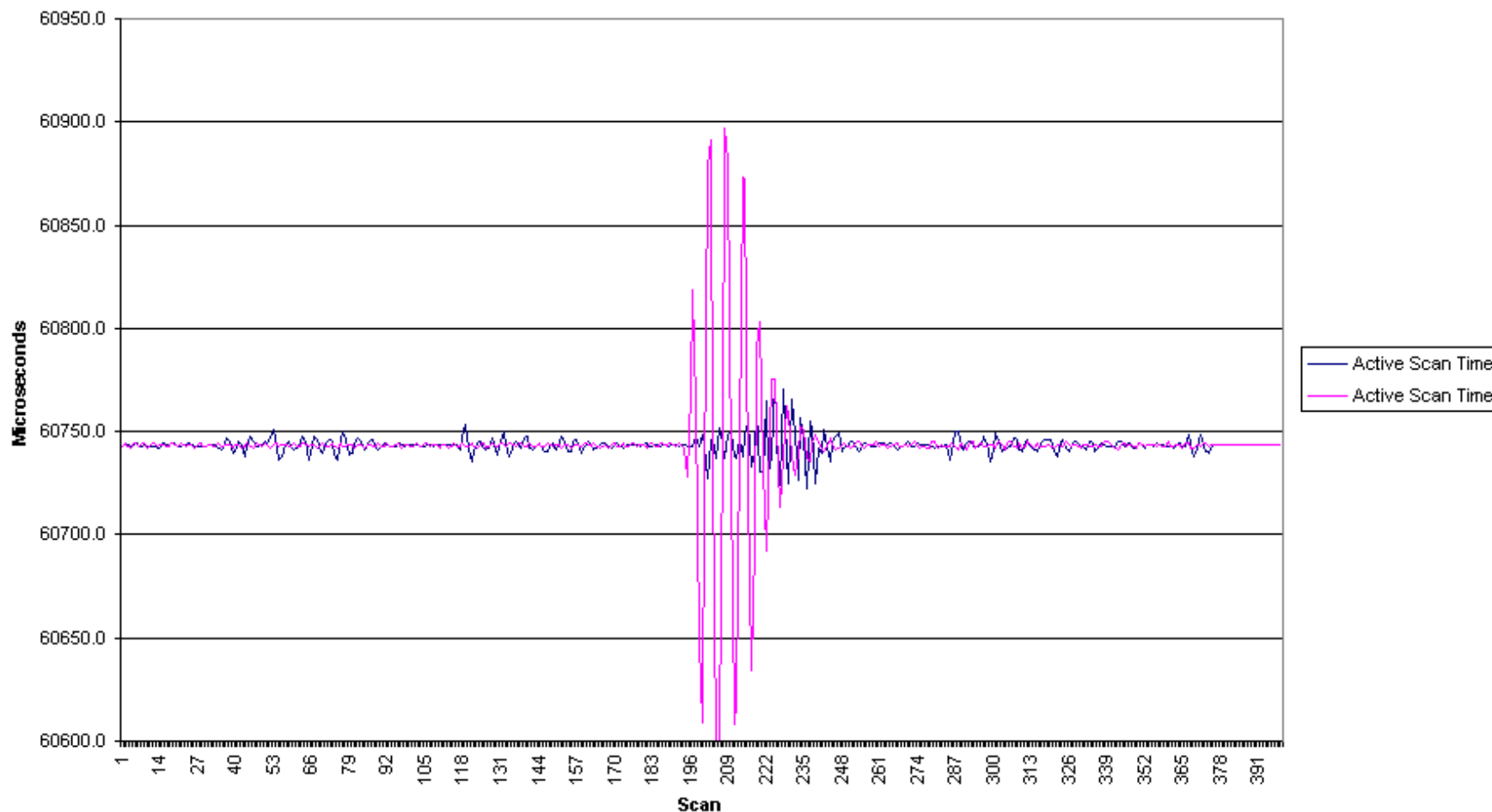
GXA Disturbance (cont.)

GXA Disturbances (cont.)

- IAS-MOC worked to characterize and fix problem

- Through simulations MOC developed new satellite configuration

  - Changes frequency and speed of motors driving GXAs

- Commands uploaded 26 April 2000

- Initial results: Major Improvement!

GXA Disturbances (cont.)
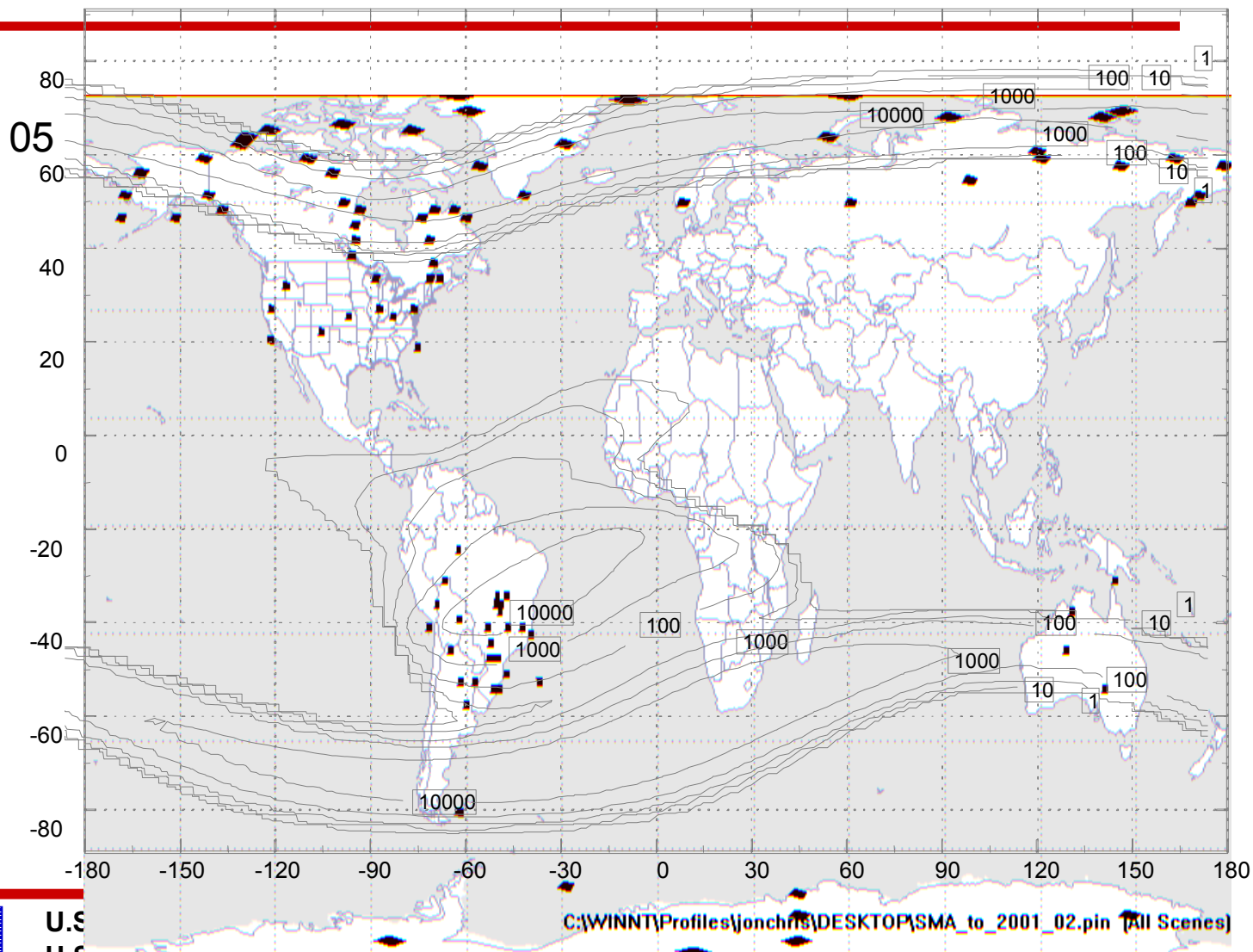
- Before/After variations in Active Scan Time (Worst case)

Scan Mirror Anomalies

- **Scanning Mechanism loses synch, 103 known to date**
  - Includes ~12-15 reported from IGS
  - Some number have not been detected/reported
- **Continuing to cluster around region of high-energy electrons**
- **No lasting effects anticipated on Landsat 7 ETM+**
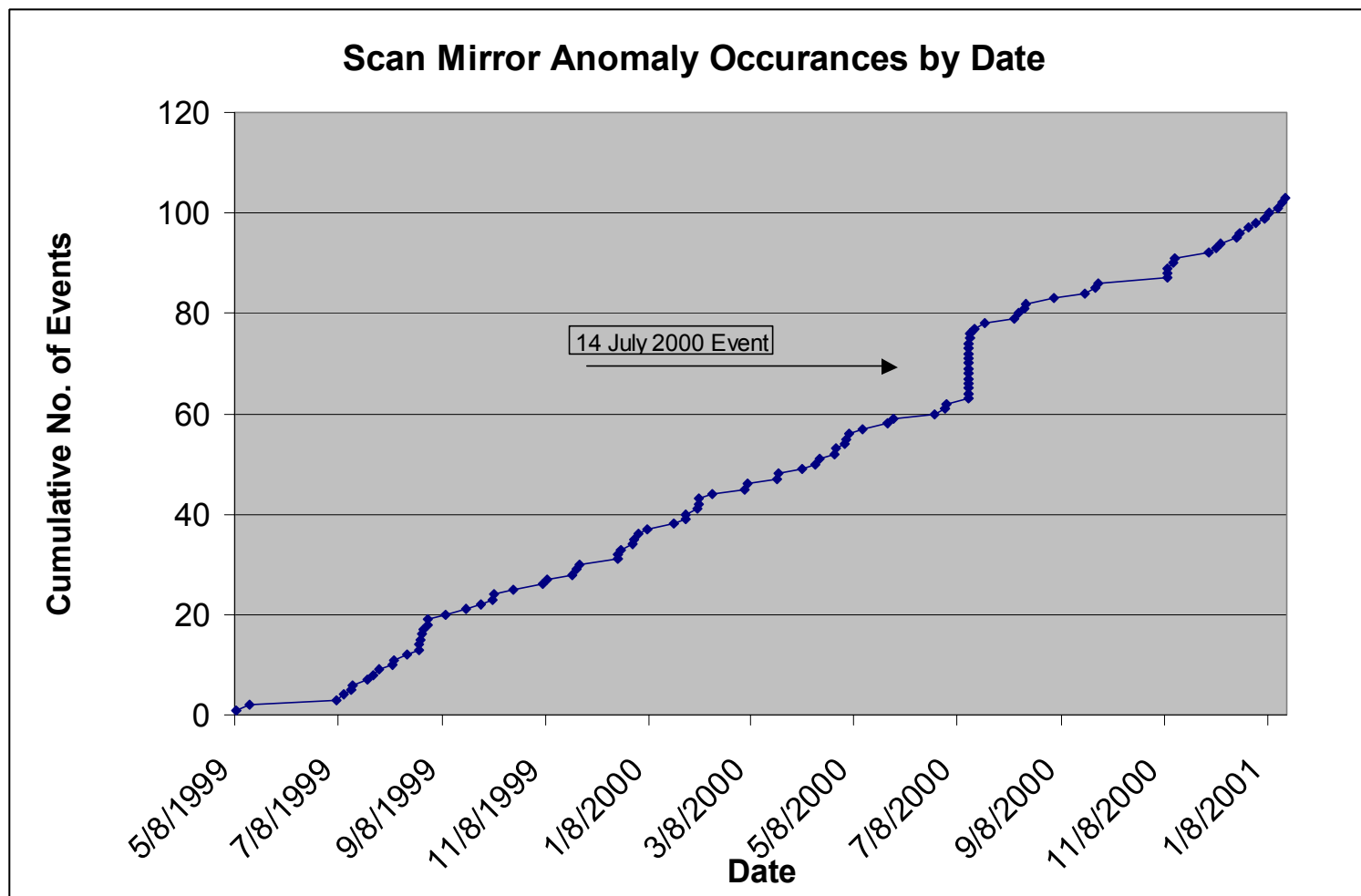
Scan Mirror Anomalies (cont.)

AE-8 Model, >1 MeV Electrons (#/cm²/s)

- Locations of SMAs as of 05 Feb 2001

C:\WINNT\Profiles\jonchris\DESKTOP\SMA_to_2001_02.pin [All Scenes]

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Scan Mirror Anomalies (cont.)

Scan Mirror Anomaly Occurances by Date

14 July 2000 Event

Particle Noise

- Minor anomaly, only recently detected

- Found while looking for noise spikes

- Occurs in all bands, all channels

- Remarkable geographic clustering
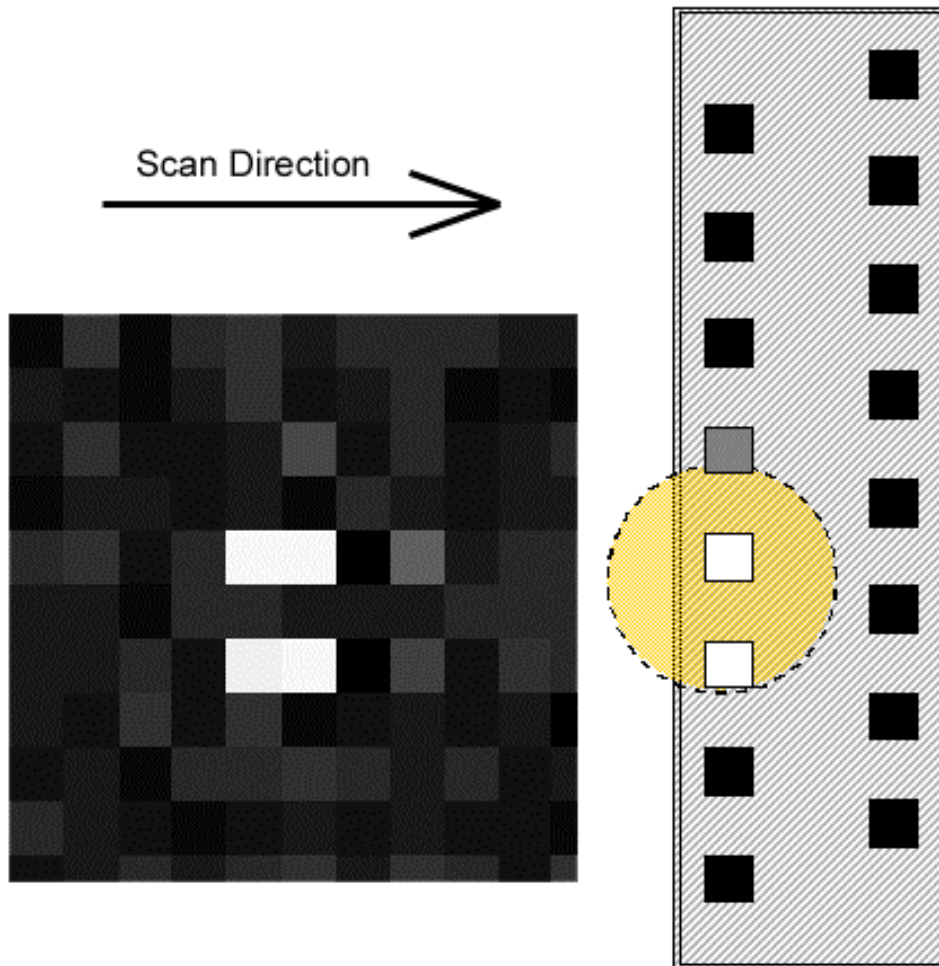
- Caused by space weather

Particle Noise (cont.)

- Infrequent, very tiny "spikes"
- Most often accompanied by low saturation

Scan Direction

(click for unedited view)

Particle Noise (cont.)

Scan Direction →
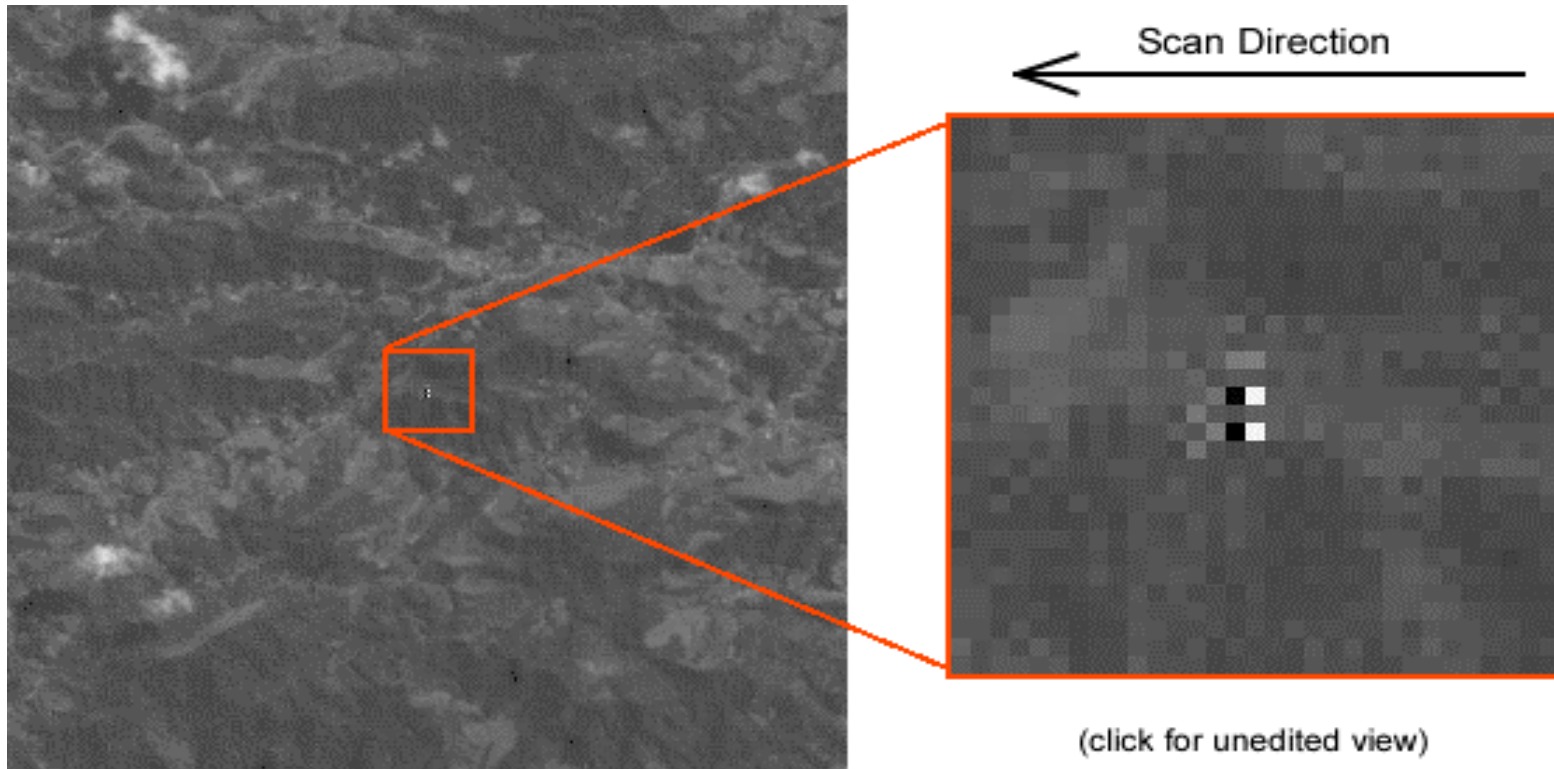
- Note that several detectors exhibit noise
- Several-pixel duration effect
- Thus <u>not</u> a classic bit-flip

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Particle Noise (cont.)

Proton Flux Contours at Altitude=705 km

NOAAPRO Model, >10 MeV Protons (#/cm^2/s)
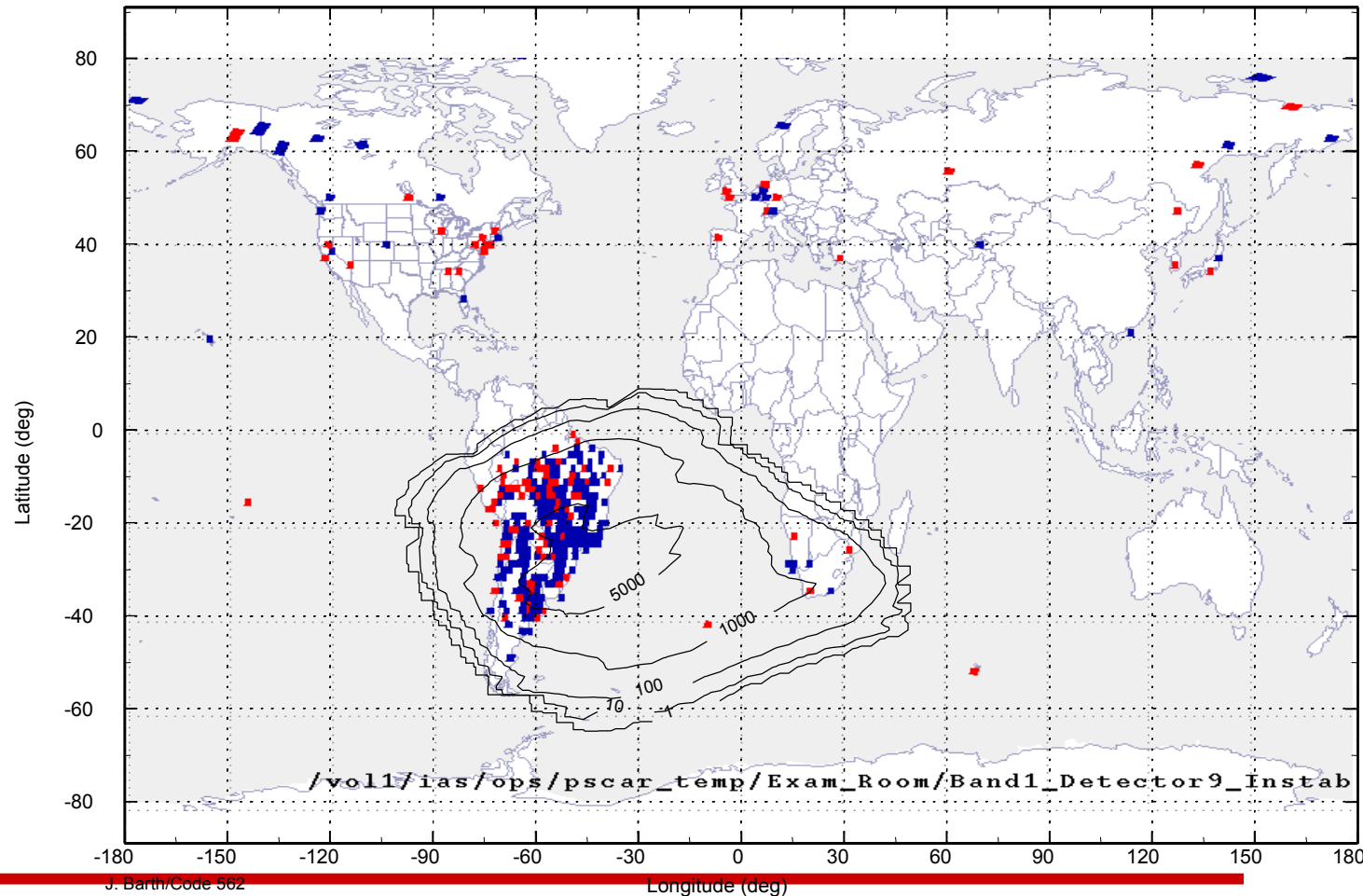
Geographic clustering:

Do you detect a trend?

(note plot is of all saturations, some may not be noise)

J. Barth/Code 562

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Results of SAA Fly-Through
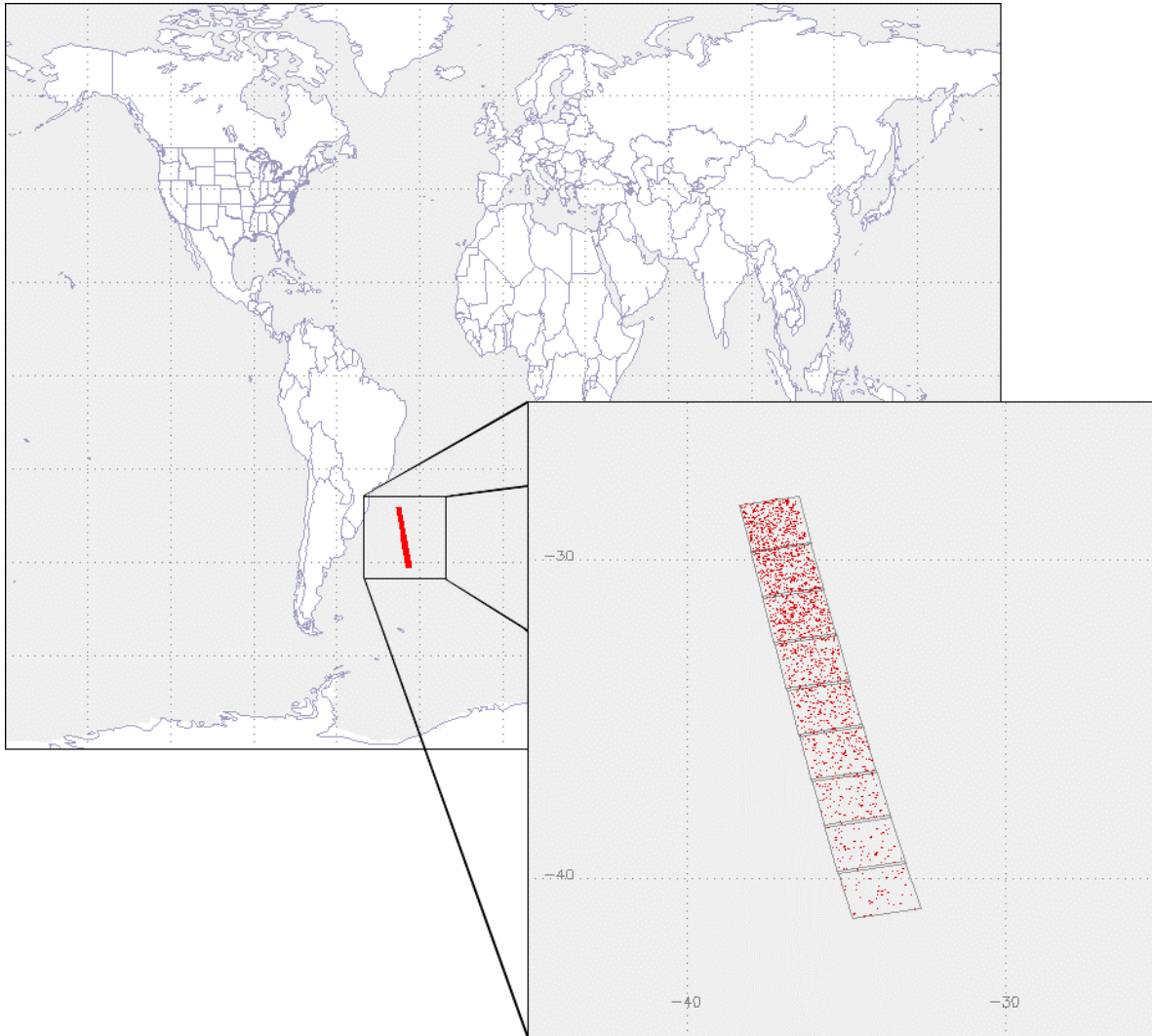
Decided to test theory by flying through the heart of the anomaly at night

Results:
Each dot in scene represents one occurrence of particle noise

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Quality Assurance

Results of Having IAS on Mission

- Landsat 7 currently one of, if not the best calibrated Earth remote sensing instrument in orbit
  - 50 CPF updates

- Anomalies found, characterized, and understood
  - Some anomalies had existed in Landsat 4 and Landsat 5, but were never followed up on
  - IAS/MOC interaction has already corrected at least two anomalies within data
  - Good working interaction between IAS, MOC and satellite engineering teams has produced effective results

Future

- Beginning steps to improve user interface, automation of many IAS tasks and analysis tools

- Working to improve interface and interaction with MOC and IAS for monitoring satellite/instrument performance near-term and long-term

- Would like to improve interfaces with capture and Level-0 processing, trending

- Work started on product verification/validation between USGS and international, VAR communities

- Working to coordinate satellite performance monitoring with international cooperators